



Urban Road Safety in the Republic of Serbia

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Abstract: Advantages of traffic have been known since the first day of traffic development. However, as society evolved so did the traffic and road safety consequently developed. In this way, the negative effects that traffic has on the society, where traffic accidents and their consequences have a leading negative effect, has started to be notices. This is also shown by the fact that an average of 1.35 million people is killed in traffic accidents a year worldwide. However, the development of the society introduces us to the new traffic consequences, such as: air and environment pollution, increased levels of ambient sounds, physical inactivity and the development of numerous diseases (cardio-vascular, respiratory, diabetes) and the onset of mental illness. Namely, it has been estimated that more than two hundred thousand people prematurely died since the beginning of this century because of air pollution and environmental hazards – traffic is largely contributing to CO₂ emissions. In this regard, the issues of urban road safety is being given increasing importance today, namely the reduce use of private passenger cars and the increasing efforts to create space for vulnerable road users. The subject of this paper is the analysis of urban road traffic safety on the territory of 20 selected local governments of the Republic of Serbia. In addition to the basic demographic characteristics of the selected local governments, the paper will present the results of a questionnaire conducted on citizens' attitudes about urban traffic safety. Although the majority of residents choose walking as the main transport mode, they believe that it is necessary to improve the infrastructure offer for active transport modes, which would significantly contribute to the development of pedestrian and bicycle traffic. A significant number of respondents exceed the speed while driving a motor vehicle, although they show that they are aware of the risks that speeding leads to, especially with regard to vulnerable road users.

Keywords: Urban road safety; Road traffic safety; Public health; Road traffic pollution.

INTRODUCTION

Living in the 21st century has become unimaginable without road traffic and all its benefits. However, as road traffic developed more and more, the negative effects and consequences that road traffic has on the social, health, ecological and economic aspects of human life also appeared. Some of the most significant negative effects are: road traffic accidents (material damage, number of injured people and fatalities), depletion of natural resources, pollution of the environment with exhaust gases and waste materials, noise, stress caused by participation in road traffic, social pollution (pollution of interpersonal relations) and similarly. As a consequence of the development of road traffic, cities around the world face problems related to unequal mobility and accessibility, pollution, road traffic accidents and the like (Mohan et al, 2017). This problem has been recognized as the "Road Traffic Safety Epidemic" (Feng Wei and Loveg-

rove, 2012), due to the fact that the built environment directly affects the dependence on the automobile, but also the socio-economic status of the individual. It is precisely this dependence on automobiles that represents a major public health problem (Douglas et al, 2011), i.e. a social issue, the solution of which is the basis for creating sustainable cities (Živković, 2021).

Referring to the definition of a road traffic accident, where it is an event that occurred on the road, in which a person is killed or injured or property is damaged, Máslaková (2017) states that a road traffic fatality is the most serious consequence of the same. However, road traffic accidents also affect the mental state of the individual. These consequences often remain long-lasting, or at least in the following period after physical recovery (Máslaková, 2017). In addition, Douglas et al. (2011) state that road traffic accidents are not the only consequence of road traffic development, they recognized that au-

tomobiles have an impact on air pollution, but also on increased ambient noise. Every year, more than a million people die prematurely due to air pollution, which causes cardiovascular diseases and the development of cancer cells, especially among vulnerable groups of road users (Douglas et al., 2011). Douglas et al. in their work state that the noise emitted by road traffic affects the development of sleep disorders, hypertension and an increase in blood pressure in people who are exposed to increased influence. Air pollution is positively associated with poorer mental health, while road traffic noise is only associated with medical prescription of anxiolytics (Klompaker et al., 2019). Air pollution and an increased level of ambient noise, as a result of traffic, contribute to an increased level of cholesterol (Sørensen et al., 2015), but also to an increased risk of heart attack, as the second cause of death in the world (Haddad et al., 2023). In addition, if the lack of green spaces in urban areas is taken into account as a contributing factor to public health, a high risk of type 2 diabetes (Sørensen et al., 2022) and a significant mental health disorder can be added to this list, especially in adolescents (Bloemsma et al., 2022).

The development of active transport modes is recognized as a good alternative to the use of private automobiles, which has a positive impact on the public health of residents and the environment (Živković and Todorović, 2020). Following the definition by Cook et al. (2022), in which they state that active transport modes include all „travels in which the sustained physical exertion of the traveller directly contributes to their motion“, they state that in addition to walking and cycling, active modes of transport also include walking, the use of wheelchairs, riding scooters and skateboards and the like (Cook et al., 2022).

Cycling is an environmentally friendly urban transport mode (Nawrath et al., 2019), which, together with walking, has positive effects in terms of physical activity and obesity (Pucher et al., 2010a; Wanner et al., 2012), cardiovascular system, type 2 diabetes and inflammatory markers (Andersen et al., 2000; Celis-Morales et al. 2017; Dinu et al., 2019; Matthews et al., 2007, Saunders et al, 2013; Shaw et al., 2020; Smith et al., 2019). By changing the transport mode and by increasing the use of active transport modes, there is an increase in the general state of health (Barajas and Braun, 2021). Nawaz and Ali (2020) state that the use of active transport modes is influenced by certain parameters, such as: social parameters (recognition of responsibility towards health and the environment), behavioural parameters (economic aspirations) and cultural parameters (laws and policies) (Nawaz and Ali, 2020).

However, active transport modes, and above all the use of bicycles, are considered as much as ten times more dangerous than driving a motor vehicle, but the results show that cities with a high share of bicycle traffic are safer, not only for cyclists, but also for all road users (Marshall et al., 2019). It is important to note that the choice of active

transport modes is significantly influenced by the sense of convenience, danger, crime rate and traffic fatalities (Fernández-Heredia et al., 2014), especially in urban areas.

With the aim of solving the problem of road traffic in today's conditions, urban road traffic safety is part of road traffic safety as a scientific discipline (Živković, 2021), it helps to establish the foundations of a new way of thinking about traffic safety. Namely, society did not always have the same problems regarding road traffic safety, so road traffic safety developed accordingly (Lipovac et al., 2014). Society has gone through five different phases of traffic safety in five different time periods: phase 1 - road traffic accidents are rare and isolated cases (until 1925/30); phase 2 - road traffic insecurity is a social problem (from 1925/30 to 1965/70); phase 3 - the first attempts to curb the growth of road traffic accidents (from 1965/70 to 1975/85); phase 4 - continuous reduction in the number and consequences of road traffic accidents (from 1975/85 to 1998); phase 5 - global road traffic safety management (since 1998). The world (including the Republic of Serbia) is still in the fifth stage of road traffic safety development, where road traffic accidents are recognized as a significant cause of death and injury to millions of people around the world. However, the further development of society, and above all the increase in the number of passenger automobiles, increasing air pollution, increasing noise resulting from road traffic, the space occupied by motor vehicles and road traffic congestion, decreasing mobility and the worsening health condition of citizens, pave the way for the new period of road traffic safety development - towards urban road traffic safety (phase 6) (Živković, 2021).

This paper will present the results of a questionnaire conducted on the territory of 20 local self-governments in the Republic of Serbia, all with the aim of identifying problems in the field of urban road traffic safety and defining the measures that need to be implemented in order to overcome them.

URBAN ROAD TRAFFIC SAFETY

As society continues to develop, and so does road traffic, which leads to new problems, i.e. the negative effects of road traffic and leads to the development of the so-called of urban traffic safety. Namely, the accelerated urbanization of developing countries presents challenges for the road traffic systems of cities, especially if their goal is to meet the mobility and accessibility needs of citizens, while on the other hand providing them with a sustainable, safe and healthy environment (GIZ, 2017). The development of the state also leads to an increase in the number of inhabitants, which necessarily leads to an increase in the road network, but also endangers the safety of (vulnerable) road traffic users. The result of this is an unnecessary increase in the number of dead and injured in road traffic accidents, which consequently en-

tails socio-economic and health consequences for both individuals and the state. The increased number of victims in road traffic accidents mainly refers to vulnerable road users, such as pedestrians, cyclists, motorcyclists, etc., who account for more than half of those killed in traffic accidents (this is the eighth cause of death in the world; WHO, 2018).

In order to improve road traffic safety in built-up environments, an urban safety management approach has been developed (GIZ, 2017). In order to be able to manage urban safety, it is necessary to:

- there is a formal safety strategy;
- road traffic safety is integrated with other urban strategies;
- all road traffic participants are taken into account, especially vulnerable participants;
- take into account the characteristics of all roads;
- there is cooperation with other sectors;
- there is engagement of a large part of the scientific community;
- there is active involvement of all road traffic participants;
- special strategies are developed for each individual city area, especially if different structures are involved;
- there are programs for monitoring realized safety goals.

Urban road traffic safety is a part of road traffic safety as a scientific discipline, but a part that is still in the initial stage of development. In this regard, Živković (2021) presented a definition, which can be considered as the basis of the development of a new concept: "Urban road traffic safety is part of the scientific discipline of road traffic safety, which studies the impact of the negative effects of traffic on society, and which, on the other hand, develops the improvement of the environment and the psycho-physical health of people in cities that are socially and economically suitable for life."

This definition covers the efforts of the scientific community to combat road traffic accidents and their consequences (fatalities and injuries), as the most common adverse impact, and exposure to traffic, i.e. environmental pollution (air pollution, noise), land use, development of mental and physical diseases etc. The goal is to create a city for residents, with enough space for vulnerable road users, with a reduced number of motor vehicles, a good public transport system, clean air, and with social and economic sustainability. It can be concluded that urban road traffic safety is a very broad concept, which, in addition to road traffic safety itself also includes urbanism, architecture, medicine and psychology, sociology and ergonomics.

RESEARCH METHODOLOGY

This paper will present the results of an on-line question-

naire conducted on the territory of 20 local self-governments in the Republic of Serbia, all with the aim of identifying problems in the field of urban road traffic safety and defining the measures that need to be implemented in order to overcome them. We have tried to collect data from several local self-governments, which are different in size and structure, using questionnaires.

The questionnaire was made in the form of an on-line questionnaire with 30 questions, which, in addition to the basic demographic questions, also included questions from the domain of road traffic safety, mobility and urban road traffic safety. The questionnaire was available to respondents in the period from March to May 2023, and the questionnaire was filled out by 1,134 respondents.

RESULTS

Demographic characteristics of the sample

Out of the entire sample of respondents who filled out the questionnaire, 43% of the respondents are male, and 57% of the respondents are female. Looking at chart 1, it can be seen that most respondents belong to the age group of 31-40 years of age (33%), which is expected, since this group is the most mobile active. While, on the other hand, the questionnaire was filled out by the least number of persons older than 65 years, only 0.4%, which can be connected with the method of distribution of the questionnaire - the on-line form of the questionnaire.

From chart 2, it can be seen that most respondents belong to the group of employed people (70%), while the fewest respondents belong to the group of retired people (only 1%), which is expected if we look at chart 1 with the percentage distribution of respondents by age.

From the point of view of road traffic safety, 7% of respondents experienced a road traffic accident in the last year. Of the total number of respondents who had a road traffic accident in the last year, the percentage of drivers and passengers in passenger cars (5 each), pedestrians (3%), bicycle drivers (2%) and motorcycle drivers (1%) stand out the most.

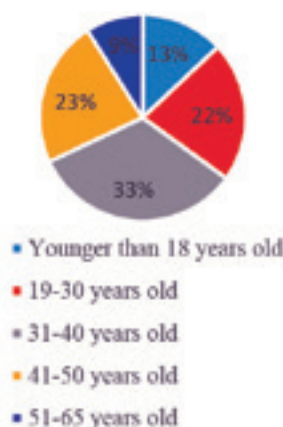


Chart 1. Percentage distribution of respondents by age

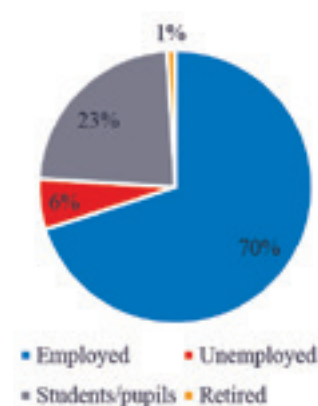


Chart 2. Percentage distribution of respondents by work status

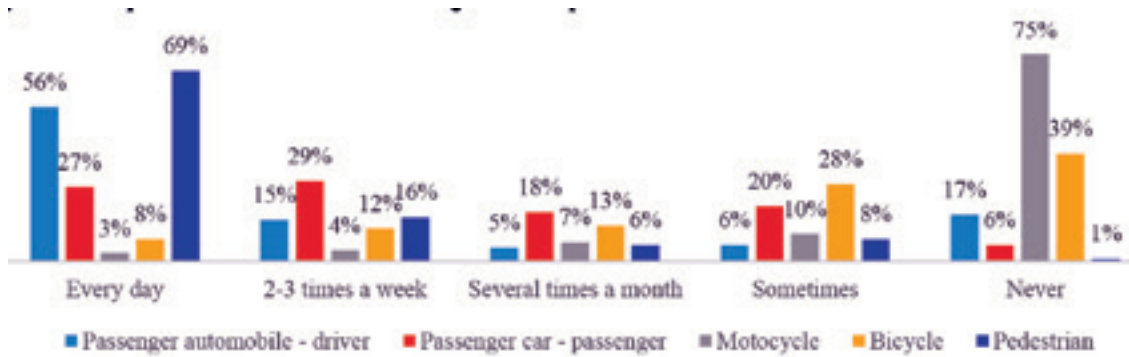


Chart 3. Percentage distribution of respondents by the type of transportation they use most often



Chart 4. Percentage distribution of respondents by reasons for using the most common transport mode

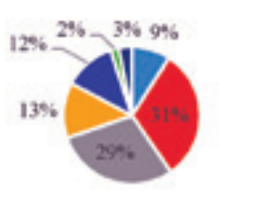
Use of different transportation modes

From chart 3, it can be seen that the highest percentage of respondents use walking as a everyday transportation mode (69%), followed by the use of a passenger car as a driver (56%). On the other hand, 75% of respon-

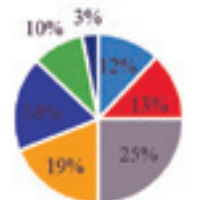
dents stated that they never use a motorcycle as a transport mode. In addition, it was observed that only 1% of respondents never choose walking as a transport mode.

On chart 4, it can be seen that most respondents choose their most common transport mode in order to save travel time (24%), followed by the distance they travel (23%).

During the use of the most common transport mode, most respondents spend between 5 and 10 minutes per day (31% - chart 5), while most of them travel between 2 and 5 km per day (25% - chart 6).



- Less than 5 minutes
- 5-10 minutes
- 10-20 minutes
- 20-30 minutes
- 30-45 minutes
- 45-60 minutes
- More than 60 minutes



- Less than 1km
- 1-2km
- 2-5km
- 5-10km
- 10-20km
- 20-40km
- More than 40km

Graph 5. Percentage distribution of respondents by the time period of the average trip by the most common transport mode

Graph 6. Percentage distribution of respondents by the length of the journey by using the most common transport mode

Road traffic safety

From the part where the demographic data of the respondents are described, it can be seen that 7% of the respondents had a road traffic accident in the last year, where road traffic accidents involving passenger automobiles stand out. In this regard, respondents were asked to recognize how dangerous certain transport modes are in the places where they live (chart 7). Percentage-wise, respondents recognize all the offered transport modes

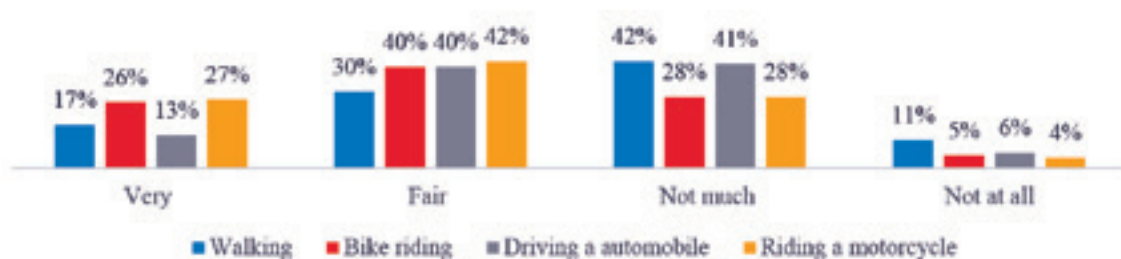


Chart 7. Percentage distribution of respondents by the opinion of how dangerous certain modes of transport are recognized

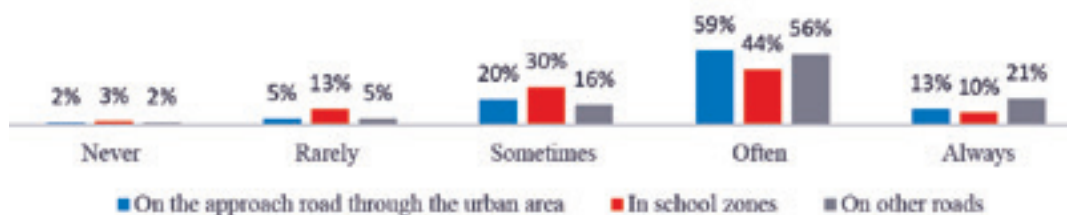


Chart 8. Percentage distribution of respondents by the opinion of how often other road users exceed the speed limit

(walking, cycling, driving a car and motorcycle) as dangerous transport modes.

Bearing these results in mind, the respondents stated their attitude as to how often other road users exceed the speed limit in certain areas (road passage through the urban area (speed limit is 50 km/h), school zone (speed limit is 30 km/h in urban areas), other roads - chart 8). From graph 8, it can be seen that the highest percentage believes that other road users exceed the speed limit in all offered areas, where the passage of the road through the urban area stands out. However, the data on speeding in the area of the school zone is particularly worrying, where it is known that children, due to their weaker psycho-physical characteristics, are less able to estimate the speed of vehicles.

Following the view that all transport modes are recognized as having a significant level of danger, the respondents stated their opinion on how safe the road traffic infrastructure is in terms of road traffic flow (chart 9). It can be seen that the largest percentage of respondents believe that the road traffic infrastructure does not provide a sufficient level required for safe road traffic (not safe at all - 17%, insufficiently safe - 43%).

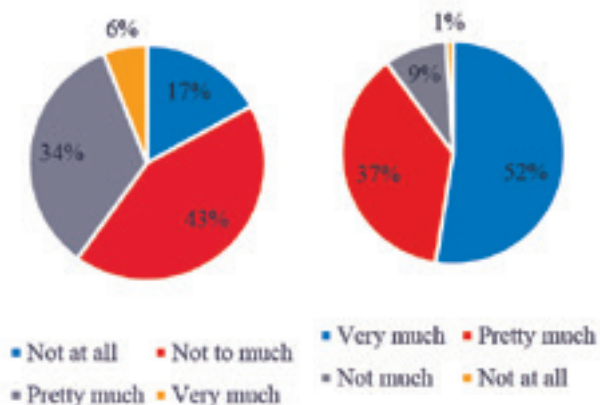


Chart 9. Percentage distribution of respondents according to their opinion on how safe the road traffic infrastructure is

Chart 10. Percentage distribution of respondents by concern regarding road traffic accidents, as one of the problems of urban road traffic safety

Following the previously mentioned results, one could expect a very high percentage of respondents' concern about road traffic accidents, which may be the result of all of the respondents' previous attitudes (very worried - 52%, fairly worried - 37% - chart 10).

Following this attitude of respondents from the previous chart, chart 11 shows that the largest percentage of respondents consider that road traffic accidents are a very important problem of urban road traffic safety that should be solved as a priority (very important problem - 75%).

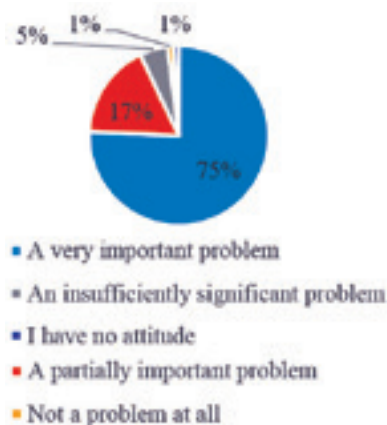


Chart 11. Percentage distribution of respondents by the recognition of road traffic accidents as an important problem of urban road traffic safety that needs to be solved as a priority

Urban road traffic safety

Urban road traffic safety, in addition to road traffic safety in a general sense, also includes citizens' attitudes about mobility, which can result in a change in the transport mode, but also in the quality of the environment. In this regard, the respondents indicated how satisfied they were with the infrastructural offer (road surface, pedestrian surface, bicycle surface). Chart 12 shows that the respondents are not satisfied with the infrastructural offer of all the offered infrastructural surfaces, which can affect the use of different modes of transport and the feeling of road traffic safety.

The quality of the infrastructure directly affects the choice of transport mode, where the attitude of the respondents regarding accessibility to everyday centres of attraction (workplace, school, store, etc.) should also be observed. Chart 13 shows that a high percentage of the respondents are satisfied with the accessibility for all the offered transport modes (in the offered transport modes, walking was deliberately omitted, bearing in mind that the other infrastructural areas are insufficiently developed).

However, the respondents recognize that it is necessary to make investments in pedestrian and bicycle in-

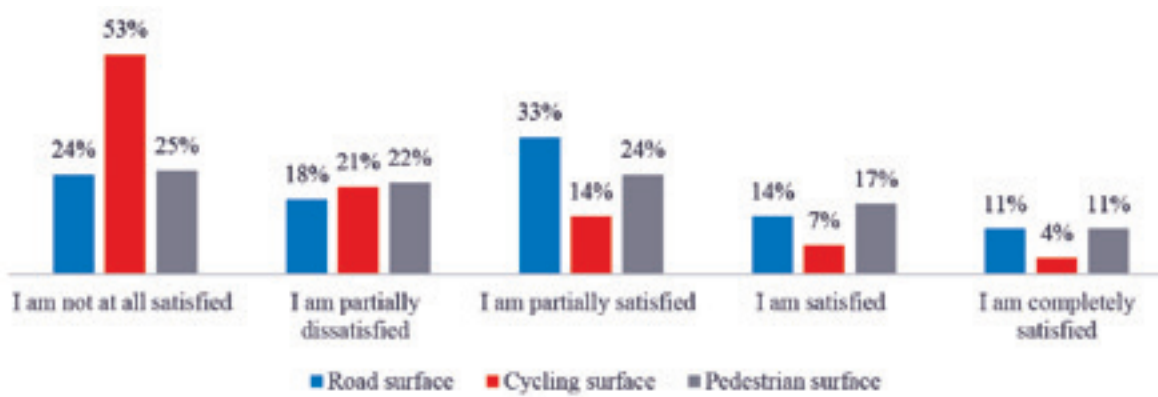


Chart 12. Percentage distribution of respondents by satisfaction with the infrastructure offer

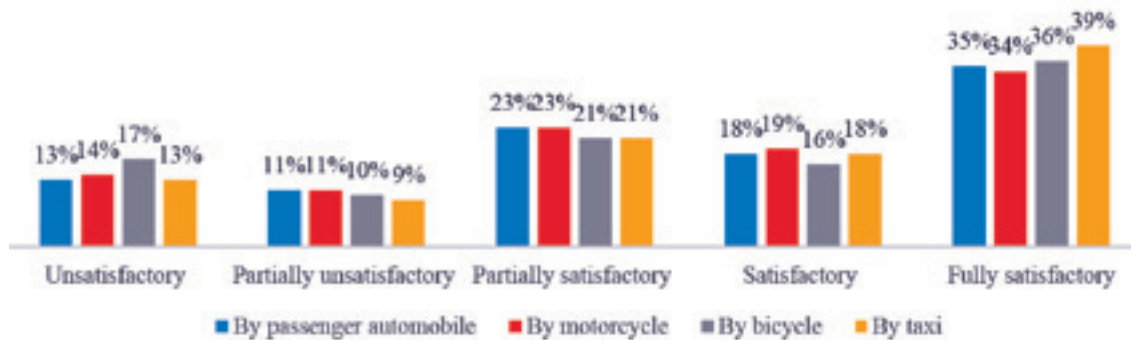


Chart 13. Percentage distribution of respondents by satisfaction in terms of accessibility

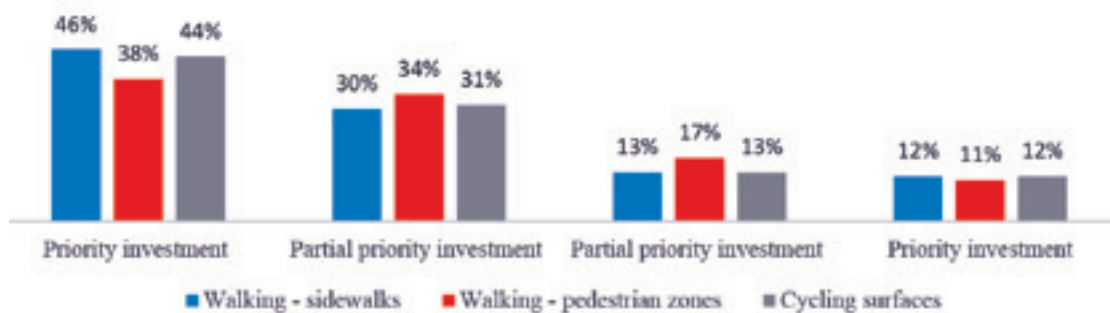


Chart 14. Percentage distribution of respondents by the attitude regarding priority investment in infrastructure area for active transport modes

frastructure (chart 14), which may result in a change in the mode of transportation and a greater use of active transport modes.

As one of the goals of urban road traffic safety is the reduction of air pollution, which is a consequence of road traffic, the respondents indicated how satisfied they were with the air quality in their places. Chart 15 shows a particularly high level of dissatisfaction with air quality (approximately 80%), where respondents recognize road traffic as the main source of air pollution (45% - chart 16), in addition to industry and households.

From the point of view of urban road traffic safety, respondents are particularly concerned about the number and consequences of road traffic accidents (52%), but they also recognize environmental pollution (49%) and road traffic congestion (40%) as factors of their concern for life in the city environments (chart 17). Although re-

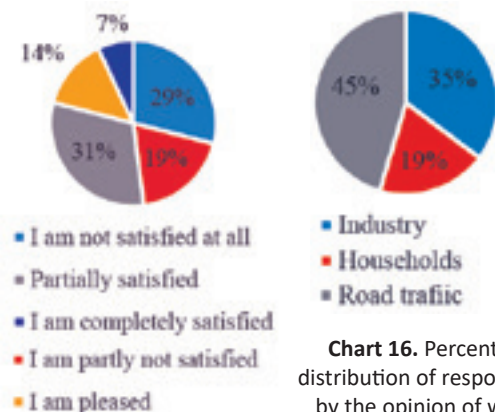


Chart 15. Percentage distribution of respondents by their attitude regarding satisfaction with air quality

Chart 16. Percentage distribution of respondents by the opinion of which factors contribute the most to air pollution

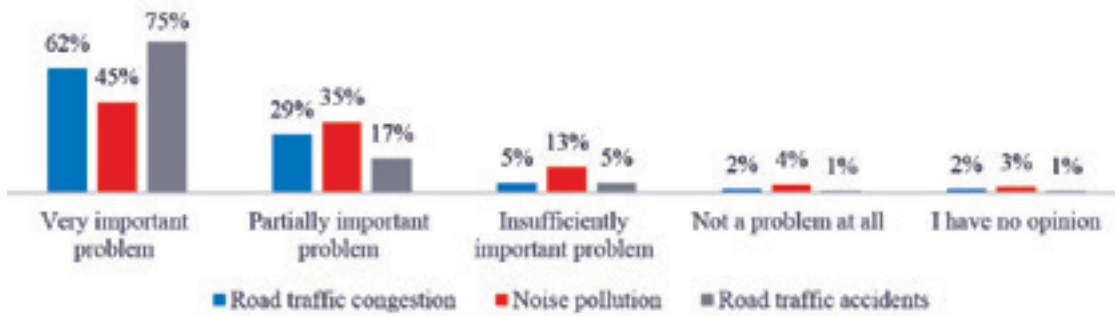


Chart 17. Percentage distribution of respondents by concern regarding the problem of urban road traffic safety

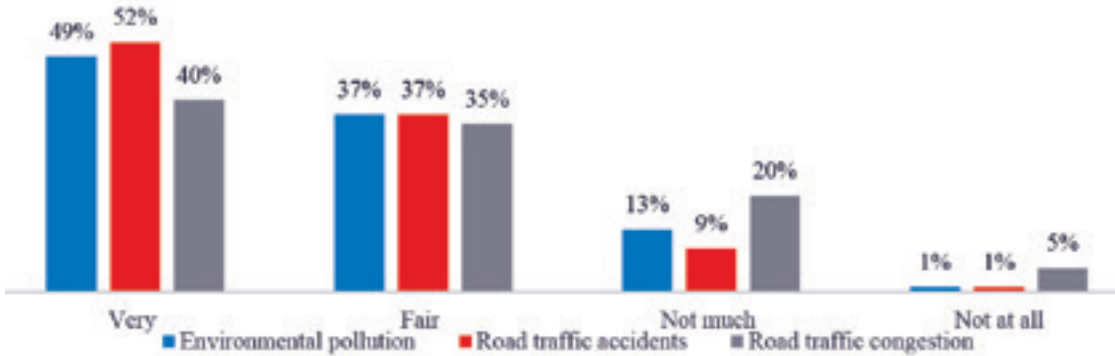


Chart 18. Percentage distribution of respondents by recognition of urban road traffic safety problems that need to be solved as a priority

spondents recognize road traffic accidents (75%) as the leading problem that needs to be solved as a priority, one can see their readiness to solve the problem of road traffic congestion (62%), but also to solve the problem of environmental noise pollution (45%) (chart 18).

Measures to improve urban road traffic safety

From the point of view of improving urban road traffic safety, respondents believe that it is necessary to improve pedestrian (27%) and cycling (25%) areas, which are actually the measures most supported by re-

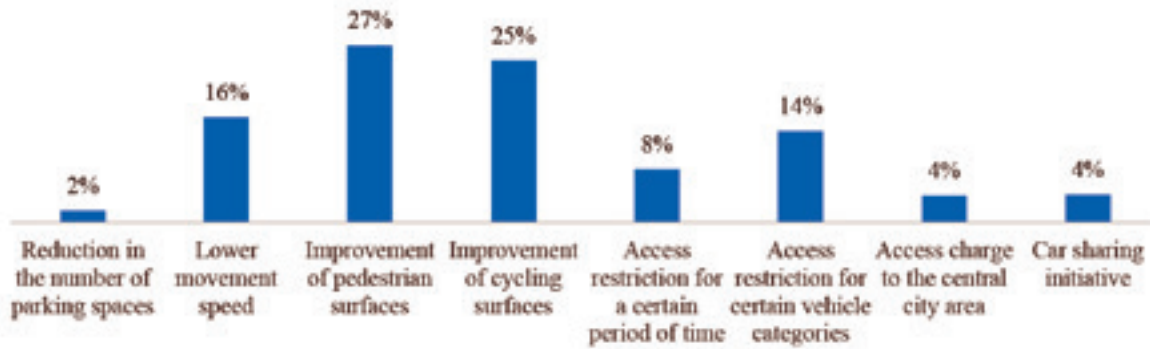


Chart 19. Percentage distribution of respondents by the measures they would support in order to improve urban road traffic safety

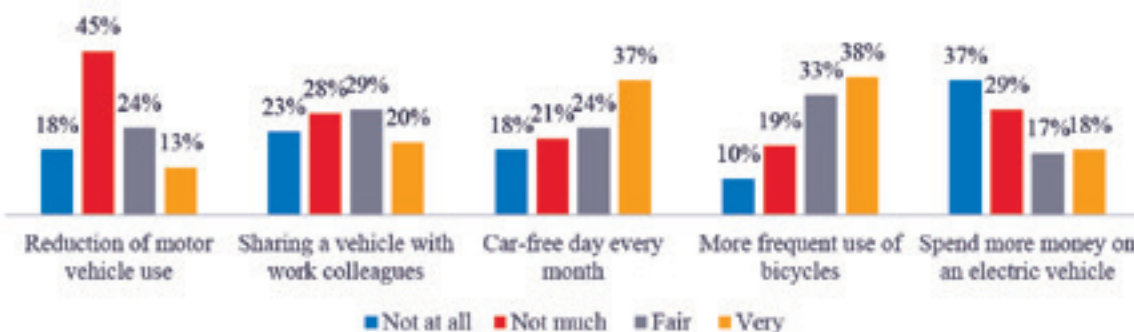


Chart 20. Percentage distribution of respondents by the recommendations they would personally accept in order to improve urban road traffic safety

spondents (chart 19). On the other hand, the measures least supported by the respondents are charging for access to the central city area and initiatives for the use of shared cars (4% each), as well as reducing the number of parking spaces (2%).

Taking into account the personal attitude of the respondents, most of them are ready to increase the use of bicycles and reduce the use of private passenger automobiles in order to improve urban road traffic safety, while allocating more money for the purchase of electric vehicles is a measure that the majority of respondents, from a personal point of view, would not support (chart 20).

DISCUSSION

In addition to benefits, the development of road traffic has also led to the appearance of negative effects, such as: road traffic accidents, pollution of the environment with exhaust gases and noise, damage to human health, occupation of public space and the like. However, unequal mobility in cities around the world and other negative effects of road traffic have led to the emergence of a "road traffic safety epidemic", which needs to be addressed in a systematic way. Road traffic has a major consequence of damaging human health, which is due to physical inactivity and the appearance of obesity, on the one hand, and the appearance of various cardio-vascular and respiratory diseases that are a consequence of air pollution, on the other hand. However, road traffic noise can also lead to the development of various mental illnesses and increased prescription of anxiolytics.

The use of active transport modes (first of all, walking and cycling) can lead to the improvement of human health and the reduction of all negative effects of road traffic, which significantly contributes to the creation of sustainable cities suitable for life. Precisely for this reason, the term "urban road traffic safety" introduces the world to a new phase of development of the thought about road traffic safety, where the goal is no longer only to reduce the number and consequences of road traffic accidents, but to reduce the impact of all the negative effects of traffic on life in urban areas.

This paper presents the results of research carried out on the territory of 20 local self-governments in the Republic of Serbia, where 1,134 respondents expressed their views on the current state of urban road traffic safety through an online questionnaire. Percentage-wise, all transport modes are represented in the total sample, where walking (69%) and the use of passenger cars by drivers (56%) stand out. In this regard, the respondents state that the main influence on the choice of their daily transport mode is the saving of travel time (24% - most respondents spend 5-10 minutes on their journey) and the distance they travel (23% - most respondents during their journey travel 2-5 km).

The largest percentage of the total sample of respondents believes that other road users often exceed the

speed limit when they are on the road passing through the urban area (with a speed limit of 50 km/h) and in school zones (with a speed limit of 30 km/h). This is precisely what leads to the feeling that all transport modes are recognized as quite dangerous by the respondents who filled out the survey questionnaire.

From the point of view of urban road traffic safety, mobility and satisfaction with the infrastructure offer are closely related to the goal of changing the mode of transportation among residents. However, the results of the conducted questionnaire show that a large percentage of respondents are not satisfied with the infrastructural offer available to them, but on the other hand, they have a high level of satisfaction with regard to the accessibility of the attraction centers towards which they gravitate every day. This is precisely what leads to the recognition of the great need for investment in infrastructure that is primarily intended for vulnerable road users, i.e. active modes of transport, such as walking and cycling. These investments and the change in the transport mode can result in a change in the respondents' attitude that road traffic is the biggest source of environmental pollution, and lead to an increase in satisfaction with air quality.

In order to contribute to the improvement of urban road traffic safety, and bearing in mind the respondents' view that it is necessary to invest in pedestrian and bicycle infrastructure, the recommendation for further work is the implementation of projects for the development of active transport modes, both at the level of the entire Republic of Serbia and at the level of each local individual self-governments. Managed in this way, there will be a change in the transport mode from private passenger automobiles to active transport modes, which further results in a healthier environment and better human health. The program for the development of active transport modes must contain an analysis of the existing and a proposal for future infrastructure, as well as promotional and preventive activities that will demonstrate the very importance of urban road traffic safety.

CONCLUSION

Urban road traffic safety is slowly introducing the world to a new phase of development of traffic safety thinking, where the goal is no longer just to reduce the number of traffic accidents, but to minimize all the negative effects of traffic functioning. In this regard, it is necessary to continue working on the development of different forms of micro-mobility, which can result in the improvement of human health, by reducing air pollution with exhaust gases and noise, and which overall can lead to the development of sustainable cities and towns that are suitable for life.

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